

REMARKS

Status of the Claims

The above amendments are presented in response to the Final Office Action dated July 29, 2008. Claims 119-123 and 125-169 are pending in the application, with claims 135 and 137-169 having been withdrawn. Claims 119-134 and 136 are rejected. Claims 119-121, 123, 125-128, 130, 134-138, 145, 156, 159, 160, 162, 164, and 165 have been amended. Claims 139, 147-155, 158, and 166-169 have been canceled without prejudice. New claim 170 is added.

Amendments to the Claims

Claim 119 is amended to recite “enzymatically coupling an antioxidant to each of a plurality of molecules to form antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer.” Support for the amendment to claim 119 can be found throughout the Specification, and specifically at paragraphs [0009], [0011], and [0037] of the published version of the present application (U.S. Patent Application Publication No.: US 2007/0010632 A1). Dependent claims 121, 123, 125-127, 130, and 134-137 have been amended to utilize language consistent with amended claim 119.

Applicants request rejoinder of claims 135 and 137 in light of the allowability of amended claim 119, from which each of the claims depends.

Claims 139, 147-155, 158, and 166-169 have been canceled without prejudice, as being related to non-elected claims for prosecution. Applicants reserve the right to pursue the canceled claims in one or more continuing applications.

Claim 138 is amended to depend from amended claim 119. Accordingly, claims 138 and 140-146, previously drawn to a non-elected group, are now within the currently elected group for examination. Applicants request rejoinder of these claims. It is also noted that claim 145 is amended to utilize diction consistent with amended claim 119.

Similarly, claim 156 is amended to depend from amended claim 119. Accordingly, claims 156, 157, and 159-165, previously drawn to a non-elected group, are now within the currently elected group for examination. Applicants request rejoinder of these claims. It is also noted that claims 159, 160, 162, 164, and 165 are amended to utilize diction consistent with amended claim 119.

New claim 170, dependent from amended claim 119, has been added. The claim recites that "the antioxidant-coupled monomers comprise at least one of a vinyl monomer, a phenolic monomer, a lactone, a lactide, and a cyclic carbonate." Support for the amendment is found throughout the present application, for example at paragraph [0066] of the published version of the present application.

No new matter has been added.

Amendment and cancellation of the claims should in no way be construed as an acquiescence to any of the Examiner's rejections and was done solely to more particularly point out and distinctly claim the invention to expedite the prosecution of the application. Applicants reserve the right to pursue the claims as originally filed in this or a separate application(s).

In light of the claim amendments and the following remarks, Applicant respectfully request that the Examiner withdraw the rejections and pass this case to issuance.

Rejections under 35 USC § 103

Claims 119-123, 125-134, and 136 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kuczkowski (*Rubber Chemical Technology*, 1984, 621-651), in view of Vermeiren (*Trends in Food Science and Technology*, 1999, 10: 77-86), Yan et al. (*Biotechnology Letters*, 1999, 21: 1051-4) and Kobayashi (*Chem Rev* 2001, 101: 3793-3818). Applicants traverse these rejections. The claims are not obvious because one of ordinary skill in the art would not have reason or motivation to combine the cited art to practice the claimed invention, and no reasonable expectation of success exists in practicing the claimed methods in light of the cited art.

A. *Independent Claim 119*

Amended claim 119 is directed to a method for enzymatically synthesizing a functionalized polymer. An antioxidant is enzymatically coupled to each of a plurality of molecules to form antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer. The antioxidant-coupled monomers are enzymatically polymerized to form the antioxidant-coupled functionalized polymer, the resultant functionalized polymer having inherent antioxidant capabilities.

The present application recognizes that an antioxidant-coupled functionalized polymer can be formed by *enzymatically coupling an antioxidant to molecules to form antioxidant-coupled monomers, which can be enzymatically polymerized*. Such methods can be advantageous, e.g., allowing reactions that are easily scalable so that large quantities can be generated, and/or easily adaptable to high throughput selective coupling while still allowing control over the degree of substitution (see paragraph [0008] of the published application). In contradistinction, the cited art is void of any teaching or suggestion of *enzymatically coupling an antioxidant to each of a plurality of molecules to form antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer*.

1. *No Reason to Combine the Cited Art to Practice the Claimed Invention*

A prima facie case of obviousness cannot be sustained against amended claim 119 because a valid reason/motivation to combine the cited art to practice the claimed invention does not exist without the teachings of the present application. In particular, one of ordinary skill in the art, in light of the cited art, has no reason or motivation to enzymatically synthesize a functionalized polymer using a step of enzymatically coupling an antioxidant to each of a plurality of molecules to form antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer. It is only with the teachings of the present application, i.e., hindsight, that an ordinary skilled artisan would be able to practice the method of amended claim 119.

None of Kuczkowski, Vermeiren, and Kobayashi, alone or in combination, teach or suggest enzymatically coupling an antioxidant to molecules to form antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer. Kuczkowski and Vermeiren are directed to aspects of antioxidants and polymers, but neither reference provides any hint of using enzymes in any manner, let alone to couple an antioxidant to molecules to form antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer.

Kobayashi also lacks any disclosure regarding enzymatically coupling an antioxidant and molecules to form antioxidant-coupled monomers. Kobayashi discloses that horseradish peroxidase (HRP) can catalyze phenol and aniline derivative coupling. But this is completely distinct from *enzymatically coupling* an antioxidant to molecules to form antioxidant-coupled monomers that are capable of forming an antioxidant-coupled functionalized polymer. Indeed, Kobayashi makes no mention at all of *antioxidant-coupled monomers* or an *antioxidant-coupled functionalized polymer*. Accordingly, Kobayashi is just as deficient as Kuczkowski and Vermeiren with regard to the missing recitations of amended claim 119.

The Office Action relies primarily upon Yan for the asserted teaching of using *C. Antarctica* lipase (CAL) to couple ascorbic acid to a vinyl ester. Even assuming *arguendo* that the reference discloses such, Yan still fails to teach enzymatically coupling antioxidants to molecules *to form antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer*. In contrast with amended claim 119, Yan et al. teaches how to form various *vitamin C fatty acid esters, which are not monomers capable of forming an antioxidant-coupled functionalized polymer*. As discussed in Applicants' previous response, the reactions taught in Yan show that after enzymatic acylation with a vinyl monomer, the *vinyl part of the molecule leaves* and the fatty chain part of the molecule is attached with vitamin C (See, Figure 1 of the Yan reference). Accordingly, Yan's product is a fatty acid ester with no vinyl group. There is no showing or suggestion by Yan, or any other of the cited art, that such fatty acid esters are monomers that can form an antioxidant-coupled functionalized polymer. Indeed, Yan has absolutely no mention at all of monomers or polymers in its entire disclosure. If anything, Yan's reaction teaches away from the claimed invention by causing the vinyl group to be separated from the final product.

Furthermore, Yan teaches away from the claimed invention in terms of context. Beyond the lack of any teaching of antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer, the reference discloses fatty acid esters of vitamin C can “improve the solubility and miscibility in a more hydrophobic environment” and therefore can be used as a food or cosmetic *additive*. Accordingly, Yan’s contribution to the art is *improved solubility* of the antioxidant so that it can be incorporated into products, such as food and cosmetics that contain fats or oils.

In contrast, the Applicants disclose a method of producing a functionalized polymer “in which the antioxidant [is] *immobilized* but yet fully functional” (See, paragraph [0005] of the published application). The Applicants explain the benefits of using an *immobilized* antioxidant that does not get added to the product in paragraph [0018] of the published application:

The present invention has many benefits over known methods of antioxidant scavenging techniques. Antioxidants specifically coupled to monomer units ensure broad and effective dispersion of the antioxidant while eliminating the particle dispersion problem of emulsions or mixtures. *Since the antioxidants do not leach out of the polymer matrix, the compositions are non-staining, non-discoloring, non-toxic, odorless and tasteless.* Immobilizing the antioxidant also improves its long term stability.

The Office Action suggests that Yan would motivate one of ordinary skill in the art to practice the claimed invention because Yan teaches that the CAL enzyme is preferable to other organic syntheses. Even if the statement is assumed *arguendo*, such motivation is only in the context of producing *fatty acid esters, not antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer*. There is a complete lack of recognition by Yan of forming monomers or polymers whatsoever. And the cited art lacks any recognition that the CAL enzyme could be used to form monomers capable of forming an antioxidant-coupled polymer.

Moreover, even if motivation or a reason exists with one of ordinary skill in the art for making antioxidant-coupled monomers that can form an antioxidant-coupled functionalized

polymer, which Applicants contend has not been shown, the ordinary skilled artisan would still not look to Yan for how to make such a monomer and/or polymer. Yan only suggests methods of forming a fatty acid ester, in which the vinyl group of a reacted vinyl ester is eliminated from the final product. There is no showing at all that such a final product could ever be used to form an antioxidant-coupled functionalized polymer, let alone enzymatically polymerized. Thus, the ordinary skilled artisan has no reason to employ Yan's teachings.

Finally, the Office Action suggests that Yan's teachings are relevant to producing a vitamin C monomer. Applicants disagree because, again, Yan is completely silent on forming monomers or polymers. To the extent that Yan's teachings of the use of CAL are relevant, they are only relevant by inappropriately including "knowledge gleaned only from the applicant's disclosure" – namely, *enzymatically coupling antioxidants to each of a plurality of molecules to form antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer*. Only the present application shows that enzymes, such as CAL, can be used to create an antioxidant-coupled monomer capable of forming an antioxidant-coupled functionalized polymer. Otherwise an ordinary skilled artisan reading Yan would only see methods of forming a non-polymerizable fatty acid ester; there is no indication that an ordinary skilled artisan could take such fatty acid esters to make an antioxidant-coupled functionalized polymer.

As the Supreme Court noted last year, to sustain an obviousness rejection, an apparent reason to combine the elements of a claim from the prior art must be determined (see *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398 (2007)). Here the Office Action's reasons, or motivations, are insufficient. Accordingly, a prima facie case of obviousness cannot be sustained.

2. *Combining the Cited Art Would Not Result in a Reasonable Expectation of Success*

The cited art also cannot support a prima facie obviousness because one of ordinary skill in the art would not have reasonable expectation of success in using the combination to arrive at the claimed invention. For instance, the cited combination would not teach one to be able to enzymatically couple antioxidants with molecules to form antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer.

As discussed above, none of Kuczkowski, Vermeiren, and Kobayashi discuss enzymatically coupling an antioxidant to molecules in any manner whatsoever. While Yan does discuss enzymatic coupling, such coupling is used to form *fatty acid esters* that are *not* antioxidant-coupled monomers capable of forming an antioxidant-coupled functionalized polymer. Yan and the remaining cited art do not teach, suggest, or even hint that enzymatic coupling can be used to form monomers that can form an antioxidant-coupled functionalized polymer. Accordingly, one of ordinary skill in the art would have no reasonable expectation of forming an antioxidant-coupled functionalized polymer since Yan's teachings could not result in the formation of a monomer capable of forming such a polymer.

As discussed in the MPEP §2143.02, "a rationale to support a conclusion that a claim would have been obvious is that *all the claimed elements* were known in the prior art and one skilled in the art could have combined the elements as claimed by known methods with *no change* in their respective functions, and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art." Here it is clear that the cited art would not have rendered a predictable result since the fatty acid esters of Yan could not be enzymatically polymerized into an antioxidant-coupled functionalized polymer.

Furthermore, as discussed in Applicants' previous paper, there is no reasonable expectation that the cited art could be altered to successfully result in Applicant's claimed invention since Yan documents that vitamin C easily degrades, and the extraction and separation of vitamin C esters is complex and results in low yields. The Office Action suggests that these problems were completely solved by Yan, and thus a reasonable expectation of success exists. Such an assertion, however, overinflates Yan's teachings. Yan's disclosure does not suggest that the synthesis of vitamin C esters have overcome all these problems. Yan simply suggests that in the context of making its fat-soluble vitamin C fatty esters, it has found some viable synthetic routes. There is no inference that Yan's teachings would in anyway result in a successful synthesis of antioxidant-coupled monomers capable of forming antioxidant-coupled functionalized polymers. Yan's fatty acid production results in the elimination of the vinyl group, which would typically be desired by an ordinary skilled

artisan to form a polymer. To suggest that Yan's disclosures make vitamin C-coupled polymers form predictable stretches the teachings beyond the breaking point. Indeed, the success of the using CAL to form antioxidant-coupled monomers is only suggested by the present application's teachings.

For at least all these reasons, there is no reasonable expectation of success that the cited art could derive the method of claim 119. Thus, amended claim 119 is patentable over the cited art.

B. Dependent Claims

Claims 120-123, 125-134, and 136 each depend ultimately from amended independent claim 119. Accordingly, each of these claims is also patentable for at least the same reasons provided for claim 119. In light of the above remarks, the Examiner is respectfully requested to withdraw the obviousness rejections. Furthermore, claims 135, 137, 138, 140-146, 156, 157, 159-165, and 170 also each ultimately depend from independent claim 119. Thus, these claims are also patentable for at least the reasons provided with regard to amended claim 119.

It is also noted that the dependent claims are also patentable for other independent reasons. For instance, new claim 170 recites that the antioxidant-coupled monomers comprise at least one of a vinyl monomer, a phenoloic monomer, a lactone, a lactide, and a cyclic carbonate. None of the cited art teaches or suggests the recitations of the new claim. Accordingly, this claim is patentable for these additional reasons as well.

CONCLUSION

In view of the foregoing remarks and the request for continued examination, reconsideration of the rejections and allowance of all pending claims is respectfully requested. In the event that the claims are not deemed to be in condition for allowance, the undersigned again requests an opportunity to interview with the Examiner. If a telephone conversation with Applicant's Attorney would expedite prosecution of the above-identified application, the Examiner is urged to call Applicant's Attorney at (617) 439-2948.

In the event that a petition for an extension of time is required to be submitted at this time, Applicant hereby petitions under 37 CFR 1.136(a) for an extension of time for as many months as are required to ensure that the above-identified application does not become abandoned.

The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 141449, under Order No. 108341-6.

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Respectfully submitted,

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